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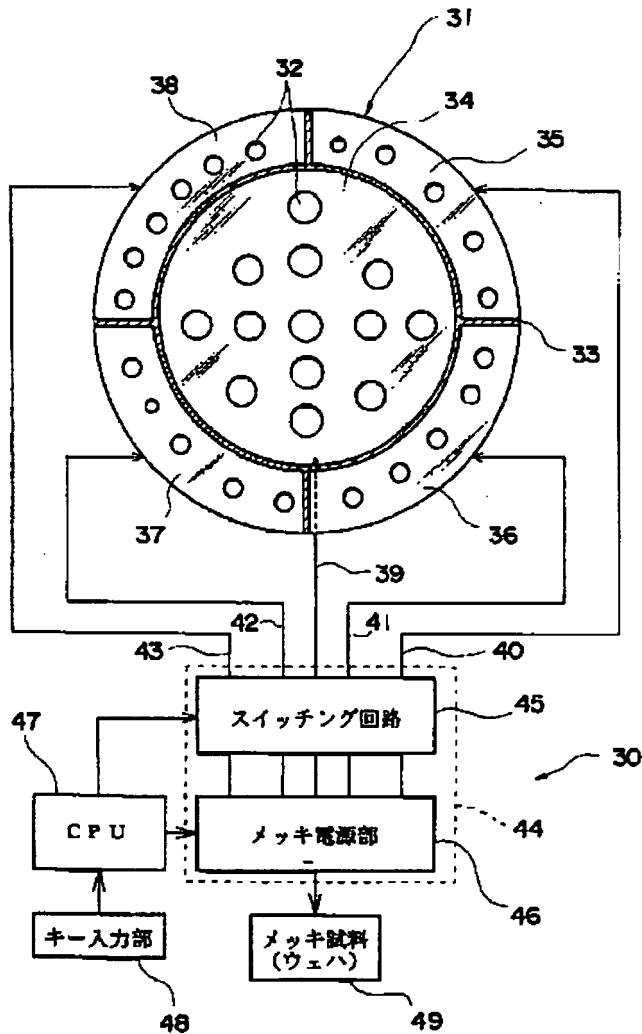
(54) [Title of the Invention] Plating Method and Plating Device

(57) [Abstract]

[Purpose] To make it possible to apply plating of a uniform thickness on a surface to be plated.

[Constitution] An anode electrode 31 is divided to a central anode electrode 34 and first to fourth peripheral anode electrodes 35 to 38 via insulating regions 33. A plating power source portion 46 of a plating current control portion 44 is a constant current source in this case. The multiple plating current outputs supplied from this power source are switched to their ON and OFF positions using a switching circuit 45. The plating current supplied to the central anode electrode 34 is turned ON for 2/3 the plating treatment time and OFF for 1/3, and the plating currents supplied to the first to fourth peripheral anode electrodes 35 to 38 are always in the ON position during the plating treatment time. With regard to the plating thickness distribution of a wafer 49, deposition is normally thick in

the central portion and thin in the peripheral portions, but bump electrodes having a uniform height are formed on the wafer 49 by controlling the energizing time in the manner described above.



- 45: Switching circuit
- 46: Plating power source
- 48: Key input portion
- 49: Plating sample (wafer)

(2)

[Claims]

[Claim 1] A plating method for depositing a plating material onto a surface to be plated which has been connected to a cathode electrode in which a plating current flows from an anode electrode while plating liquid is being sprayed on the cathode electrode side, wherein

either the energizing time of the plating current flowing to the aforementioned anode electrode or the amount of current, or both the energizing time and amount of current are partially adjustable in response to electrode position, such that the thickness of plating deposited on the cathode electrode side is controlled

[Claim 2] A plating device for depositing a plating material onto a surface to be plated in which a sample is disposed having a surface to be plated that has been connected to a cathode electrode on the top surface of a cup in which plating liquid is sprayed, such that the plating current flows from an anode electrode within the cup to the cathode electrode side, wherein

the aforementioned anode electrode is divided into multiple electrode areas via insulation areas,

the aforementioned anode electrode is arranged with the multiple divided anode electrodes respectively connected, and a means for controlling plating current is provided such that either the energizing time of the plating current flowing to each of these anode electrodes, or the amount of current, or both the energizing time and the amount of current are adjustable, and

the distribution of plating thickness deposited on the cathode electrode is controlled by the divided anode electrodes through which the aforementioned controlled plating current flows

[Detailed Description of the Invention]

[0001]

[Industrial Field of Application] This invention pertains to a plating method and plating device, particularly with regard to deposition of plating material onto a surface in which plating liquid is sprayed.

[0002]

[Prior Art]

Conventionally, in cases where bump electrodes are formed on a semiconductor wafer, a plating device for wafers is used to apply gold or solder onto the surface of the wafer prior to the formation of the bump electrodes.

[0003] Fig. 4 is a cross-sectional view of the structure of a plating device 1 for wafers. In Fig. 4, the plating device 1 for wafers is equipped with a cup 3 on the inside of the plating tank 2. This cup 3 comes with a ring-shaped rubber scat 3a on the top surface of the housing of the cup 3, and the plating tank 2 and cup are connected via a liquid pathway 4. A spray pump 7 is included in this liquid pathway 4 for the purpose of spraying a plating liquid 5 containing ionized gold that is stored within the plating tank 2 into the cup 3 from the plating liquid spray nozzle 6 installed at the center of the bottom inside the cup 3. Further, a net-shaped anode electrode 8 is provided at the bottom portion inside the cup 3, and a lead wire 9 is connected to the positive pole of a plating power source, not shown in the drawing.

[0004] Fig. 5 is a drawing showing a conventional form of an anode electrode 8 as well as the connection pattern between this electrode, the plating power source 22 and wafer 13. As shown in Fig. 5, the anode electrode 8 is equipped with multiple plating liquid permeation holes 21, and the plating liquid that is sprayed from plating liquid spray nozzle 6 shown in Fig. 4 passes through these plating liquid permeation holes 21 as it is sprayed into the cup 3. Further, on the positive pole side of the plating power source 22, an individually formed anode electrode 8 is connected using a lead wire 9, and on the negative pole side, a wafer (plating sample) 13 is connected on the cathode electrode side using a lead wire 12.

[0005] Returning to Fig. 4, the upper wall portion of the cup 3 is equipped with plating liquid exit holes 10. The upper surface of the rubber seat 3a is equipped with an abbreviated L-shaped cathode electrode 11 on the side surface, and this cathode electrode 11 is connected to the positive pole of the plating power source 22 shown in Fig. 5 using a lead wire 12.

[0006] A wafer 13 that is to undergo plating treatment is turned with the surface to be plated facing downward such that the rubber seat 3a and top surface of the cathode electrode 11 fit closely along the periphery of the bottom surface of the wafer 13.

[0007] Then, once the spray pump 7 of the wafer plating device 1 is activated, the plating liquid 5 that is stored in plating tank 2 is sprayed into the cup 3 from the plating liquid spray nozzle 6 as it passes through the anode electrode 8, such that the spray makes contact with the center of the bottom surface of the wafer 13. The plating liquid 5 that is sprayed onto the center of the bottom surface of the wafer 13 flows in a radial direction toward the outside along the bottom surface of the wafer 13, after which it flows outward

through the plating liquid exit holes 10 as indicated by the arrows shown in Fig. 4 and is then recovered in the plating tank 2. At this point, as the plating liquid flows between the anode electrode 8 and cathode electrode 11, bump electrodes are formed at specific locations on the lower surface of the wafer 13 through the application of the gold plating material.

[0008] Fig. 6 is a line graph that shows the relationship between bump electrode height and wafer position when a conventional wafer plating device is used to make deposits onto a wafer surface.

[0009]

[Problem to Be Solved by the Invention]

However, through the use of this type of conventional plating device, as shown in Fig. 6, it is apparent that the height of the deposited bump electrodes is higher in the center of the wafer 13 (shown by height a) and becomes lower as it moves toward the periphery of the wafer 13 (shown by height b). As such, due to the occurrence of dispersion in the height of the deposited bump electrodes according to the position on the wafer, a problem exists in which variations occur in the manufacturing conditions for IC chips, etc., which are formed in the center and peripheral portions of wafers 13.

[0010] As noted above, it is not absolutely clear as to the cause for the dispersion in the height of bump electrodes deposited onto the surface of wafers 13. However, as shown in Fig. 4, plating liquid flows along the electrical field in the center of the wafers 13, and the metallic ions within the plating liquid are in a state in which they are efficiently moved and easily deposited. Further, since the plating liquid flows in a perpendicular direction to the electrical field at the peripheral portions of the wafer 13 (see arrows in the drawing),

the metallic ions flow in a horizontal direction before they are moved to the surface of the wafer 13, and therefore it is believed that the deposition amount varies between the center portion and peripheral portions.

[0011] Thus, the objective of this invention is to provide a plating method and plating device in which plating can be applied at a uniform thickness along the surface to be plated.

[0012]

[Means for Solving the Problem] As a way to achieve the aforementioned objective with regard to the plating method noted in Claim 1, this is a method for depositing a plating material onto a surface to be plated which has been connected to a cathode electrode in which a plating current flows from an anode electrode while plating liquid is being sprayed on the cathode electrode side, and according to this method, either the energizing time of the plating current flowing to the aforementioned anode electrode or the amount of current, or both the energizing time and amount of current are partially adjustable in response to electrode position, such that the thickness of the plating deposited on the cathode electrode side is controlled.

[0013] As a way to achieve the aforementioned objective with regard to the plating device noted in Claim 2, this is a device for depositing a plating material onto a surface to be plated in which a sample is disposed having a surface to be plated that has been connected to a cathode electrode on the top surface of a cup in which plating liquid is sprayed, such that the plating current flows from an anode electrode within the cup to the cathode electrode side, and in this device, the aforementioned anode electrode is divided into multiple electrode areas via insulation areas, the multiple divided anode electrodes

are respectively connected, a means for controlling plating current is provided such that either the energizing time of the plating current flowing to each of these anode electrodes, or the amount of current, or both the energizing time and the amount of current are adjustable, and the distribution of plating thickness deposited on the cathode electrode is controlled by the divided anode electrodes through which the aforementioned controlled plating current flows.

[0014]

[Operation] According to the plating method noted in Claim 1, either the energizing time of the plating current flowing to the aforementioned anode electrode or the amount of current, or both the energizing time and amount of current are partially adjustable in response to electrode position, such that the thickness of the plating deposited on the cathode electrode side is controlled.

[0015] Accordingly, in cases where the distribution of the plating thickness deposited onto the surface to be plated becomes uneven, the plating conditions are partially altered in response to this uneven distribution, making it possible to correct the situation so that the plating material is deposited at a uniform thickness.

[0016] In the plating device noted in Claim 2, the anode electrode is divided into multiple electrode areas via insulation areas, and through a means for controlling plating current, either the energizing time of the plating current flowing to each of these anode electrodes, or the amount of current, or both the energizing time and the amount of current are adjustable.

[0017] Therefore, by using a divided set of anode electrodes, the conditions of the plating current flowing to each of these anode electrodes can be changed, making it

possible to control the distribution of the thickness of the plating deposited on the cathode electrode side.

[0018]

[Embodiments] This invention is further described below based on embodiments.

[0019] Figs. 1 – 3 are drawings that describe the plating device related to this invention.

[0020] First, a description of the structure is provided.

[0021] Fig. 1 is a block diagram that shows the structure of the wafer plating device 30 according to this embodiment. In Fig. 1, the wafer plating device 30 is composed of the following: an anode electrode 31, plating liquid permeation holes 32, insulation areas 33, a central anode electrode 34, a first peripheral anode electrode 35, a second peripheral anode electrode 36, a third peripheral anode electrode 37, a fourth peripheral anode electrode 38, lead wires 39, 40, 41, 42, and 43, a plating current controller 44, a switching circuit 45, a plating power source 46, a CPU 47, a key input portion 48, and a plating sample (wafer) 49.

[0022] In this embodiment, the anode electrode 31 is divided into five electrode areas via insulation areas 33. Since the plating deposition amount varies between the central portion of the wafer and the peripheral portions on the cathode electrode side, the anode electrode 31 is divided into a central anode electrode 34 and its peripheral portions arranged in a radial fashion, namely the first peripheral anode electrode 35, second peripheral anode electrode 36, third peripheral anode electrode 37, and fourth peripheral anode electrode 38. Thus, in cases where the plating thickness deposited onto a surface to be plated on the cathode side is to be controlled, an anode electrode is selected while the energizing time and amount of current flowing to each anode electrode is altered. The

plating current controller 44 is connected to the aforementioned central anode electrode 34, first peripheral anode electrode 35, second peripheral anode electrode 36, third peripheral anode electrode 37, and fourth peripheral anode electrode 38 via the lead wires 39, 40, 41, 42, and 43, respectively.

[0023] Here, the plating current controller 44 is composed of a switching circuit 45 and plating power source 46. For example, to provide a source of constant current from the plating power source 46, the switching circuit 45 conducts a switching operation in response to the multiple outputs generated from the plating power source 46, and the duty ratio, which is the ratio between the ON time in which current flows and the OFF time in which current does not flow, is altered so that the plating deposition amount is controlled.

[0024] Further, without using the switching circuit 45, it is also acceptable to control the plating deposition amount by altering the current amount output from the plating power source 46 to each anode electrode.

[0025] In addition, it is acceptable to control the plating deposition amount by altering the current amounts output from the aforementioned plating power source 46 to each anode electrode in combination with one another.

[0026] According to the plating thickness distribution data input from the key input portion 48, the CPU 47 makes a calculation to determine how the energizing control of the plating current is to be conducted in response to a given anode electrode, and based on the results of this calculation, the switching operation of each switching element within the switching circuit 45 of the plating current controller 44 is controlled, as are the current amounts output from the multiple output terminals of the plating power source 46. According to this, the height of the bump electrodes deposited onto the wafer surface 49

to which a cathode electrode is connected can be controlled, for example, such as to make each height the same.

[0027] The operation of the plating device noted in this embodiment is further described below based on the structure noted above.

[0028] Fig. 2 is a line graph that shows an example of the plating current wave form when the energizing operation is conducted for each anode electrode. Fig. 3 is a line graph that shows the relationship between bump electrode height and wafer position when the wafer plating device described in this embodiment is used to make deposits onto a wafer surface.

[0029] First, when the wafer plating device 30 that is shown in Fig. 1 conducts plating treatment by energizing the anode electrode 31 as a whole with the same plating current as in the case of a conventional device, bump electrodes are deposited onto the surface to be plated with the type of distribution indicated by Line A in Fig. 3. That is to say, the bumps in the center portion of the wafer area are high while those along the peripheral portions are low.

[0030] Thus, in cases where bumps on a wafer 49 are to be formed with a uniform height, the energizing process is conducted by applying plating currents that vary between the central anode electrode 34 and the first to fourth peripheral anode electrodes 35 – 38. Specifically, to provide a source of constant current from the plating power source 46 shown in Fig. 1, a constant amount of current is provided from this power source, and by controlling the ON/OFF modes for the current from this plating power source 46 using the switching circuit 45, specific plating current wave forms are formed as shown in Fig. 2. In this fashion, by altering the ratio between the ON time and OFF

time of the plating current wave form (duty ratio), it becomes possible to change the plating deposition speed.

[0031] As shown in Fig. 2, according to this embodiment, during the time between the startup and conclusion of the electroplating treatment, continuous energizing of the first to fourth peripheral anode electrodes 35 – 38 is conducted in the ON position, while with respect to the central anode electrode 34, 2/3 of the plating treatment time is in the ON position and 1/3 is in the OFF position, such that, for example, plating times T_1 and T_2 are ON, T_3 is OFF, T_4 and T_5 are ON, T_6 is OFF, and so forth. At this point, during the T_1 and T_2 times, the same plating current is used in energizing the anode electrode 31 as a whole, resulting in the type of distribution indicated by Line A in Fig. 3. Next, during the T_3 time, only the first to fourth peripheral anode electrodes 35 – 38 are energized with the plating current, resulting in the formation of bumps in the central portion of the wafer 49 with reduced height and bumps in the peripheral portions with increased height, such that the distribution is as indicated by Line B in Fig. 4 [sic; should be Fig. 3].

[0032] Accordingly, with the wafer plating device 30 described in this embodiment, by controlling the energizing level of the plating current as noted above, bump electrodes are formed with the composite distribution conditions as indicated by Lines A and B in Fig. 3.

[0033] That is to say, as indicated by Line C in Fig. 3, it is possible to deposit bump electrodes on the wafer that are uniform in height from the central portion to the peripheral portions. In cases where it is desired to form thicker bump electrodes while maintaining this level of uniformity, the plating current control method noted above can be repeated. By doing this, the bump electrodes can be formed while the height

distribution conditions of the bump electrodes deposited onto the wafer surface remain flat.

[0034] As discussed above, the plating device related to this embodiment has an anode electrode that is made up of multiple divided parts, and by changing the amount of plating current and/or the energizing time in response to the positions of the respective anodes, the distribution of plating thickness deposited onto a surface to be plated can be changed, making it possible to form bump electrodes with uniform height over the entire wafer surface.

[0035] Note that in the embodiment above, the current amount delivered from the plating power source 46 shown in Fig. 1 is constant, and through a switching operation using the switching circuit 45, the energizing time is altered, thus controlling the plating thickness distribution. However, the controlling means is not limited to this.

[0036] However, besides what is noted above, although the energizing time is constant, the current amount delivered from the plating power source 46 can be changed for each anode electrode, making it possible to control plating thickness distribution.

[0037] Further, through the switching operation of the switching circuit 45 noted above, the energizing amount delivered from the plating power source 46 can be changed along with the energizing time that [the current] flows to each anode electrode, making it possible to control the plating thickness distribution.

[0038] Further, in the embodiment noted above, the height of the bump electrodes formed on the wafer surface has been controlled to provide a uniform height. However, this is not a limiting factor, and therefore it is possible to intentionally form bump

electrodes at specific locations on the wafer at which the comparative heights may be greater or lower, as the case warrants.

[0039] In addition, the anode electrode in the embodiment noted above is applied in the form of an electrode that is divided into five areas. However, the number of divisions and the configuration of the divisions are not limiting factors, and therefore the configuration and number of divisions can be selected and applied as seen fit for the purpose of controlling plating thickness.

[0040]

[Effect of the Invention] According to the plating method noted in Claim 1, either the energizing time of the plating current flowing to the anode electrode or the amount of current, or both the energizing time and amount of current are partially adjustable in response to electrode position, such that the thickness of the plating deposited on the cathode electrode side is controlled. Therefore, even if the distribution of the plating thickness deposited on a surface is uneven, by applying a plating treatment in response to this uneven distribution condition, plating can be deposited onto a surface to be plated at a uniform thickness, and the plating thickness can be controlled to meet a desired distribution condition.

[0041] According to the plating device noted in Claim 2, the anode electrode is divided into multiple electrode areas via insulation areas, and a means for controlling plating current is provided such that either the energizing time of the plating current flowing to each of these anode electrodes, or the amount of current, or both the energizing time and the amount of current are adjustable. Therefore, it becomes possible to deposit plating material onto a surface to be plated at a uniform thickness, as well as to control the

thickness of the plating deposited on the cathode electrode side to meet a desired distribution condition.

[Brief Description of the Drawings]

[Fig. 1] This is a block diagram that shows the structure of the wafer plating device according to this embodiment.

[Fig. 2] This is a line graph that shows an example of the plating current wave form when the energizing operation is conducted for each anode electrode.

[Fig. 3] This is a line graph that shows the relationship between bump electrode height and wafer position when the wafer plating device described in this embodiment is used to make deposits onto a wafer surface.

[Fig. 4] This is a cross-sectional view of the structure of a plating device for wafers.

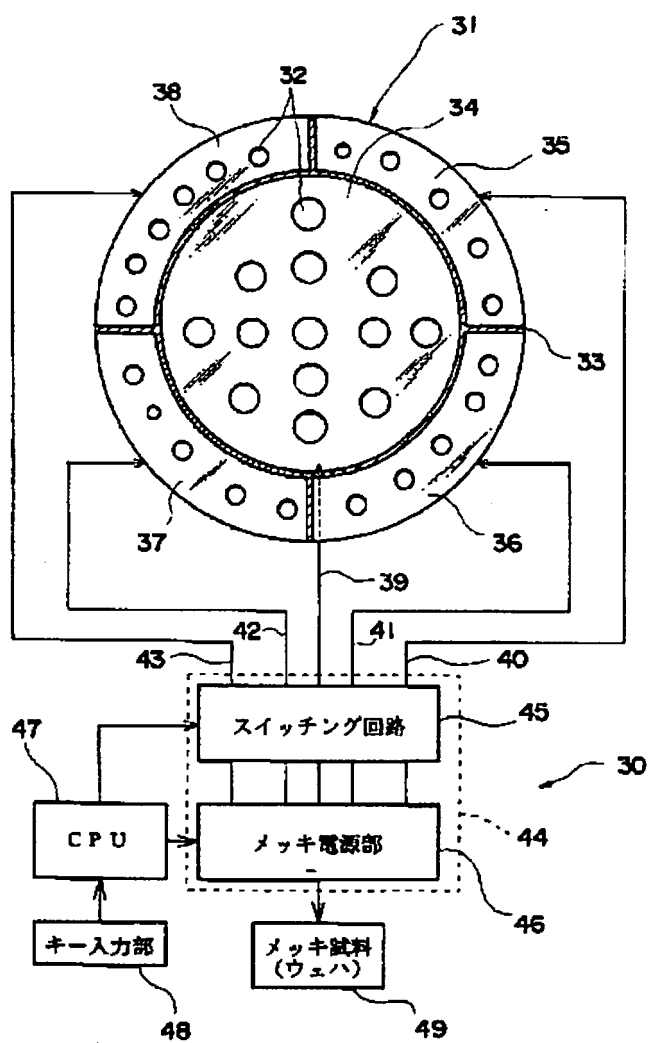
[Fig. 5] This is a drawing showing a conventional form of an anode electrode as well as the connection pattern between this electrode, the plating power source, and the wafer.

[Fig. 6] This is a line graph that shows the relationship between bump electrode height and wafer position when a conventional wafer plating device is used to make deposits onto a wafer surface.

[Description of Symbols]

- 30: Wafer plating device
- 31: Anode electrode
- 32: Plating liquid permeation hole
- 33: Insulation area
- 34: Central anode electrode
- 35: First peripheral anode electrode
- 36: Second peripheral anode electrode
- 37: Third peripheral anode electrode
- 38: Fourth peripheral anode electrode
- 39, 40, 41, 42, and 43: Lead wire
- 44: Plating current controller
- 45: Switching circuit
- 46: Plating power source
- 47: CPU
- 48: Key input portion
- 49: Plating sample (wafer)

Fig. 1



- 45: Switching circuit
- 46: Plating power source
- 48: Key input portion
- 49: Plating sample (wafer)

Fig. 2

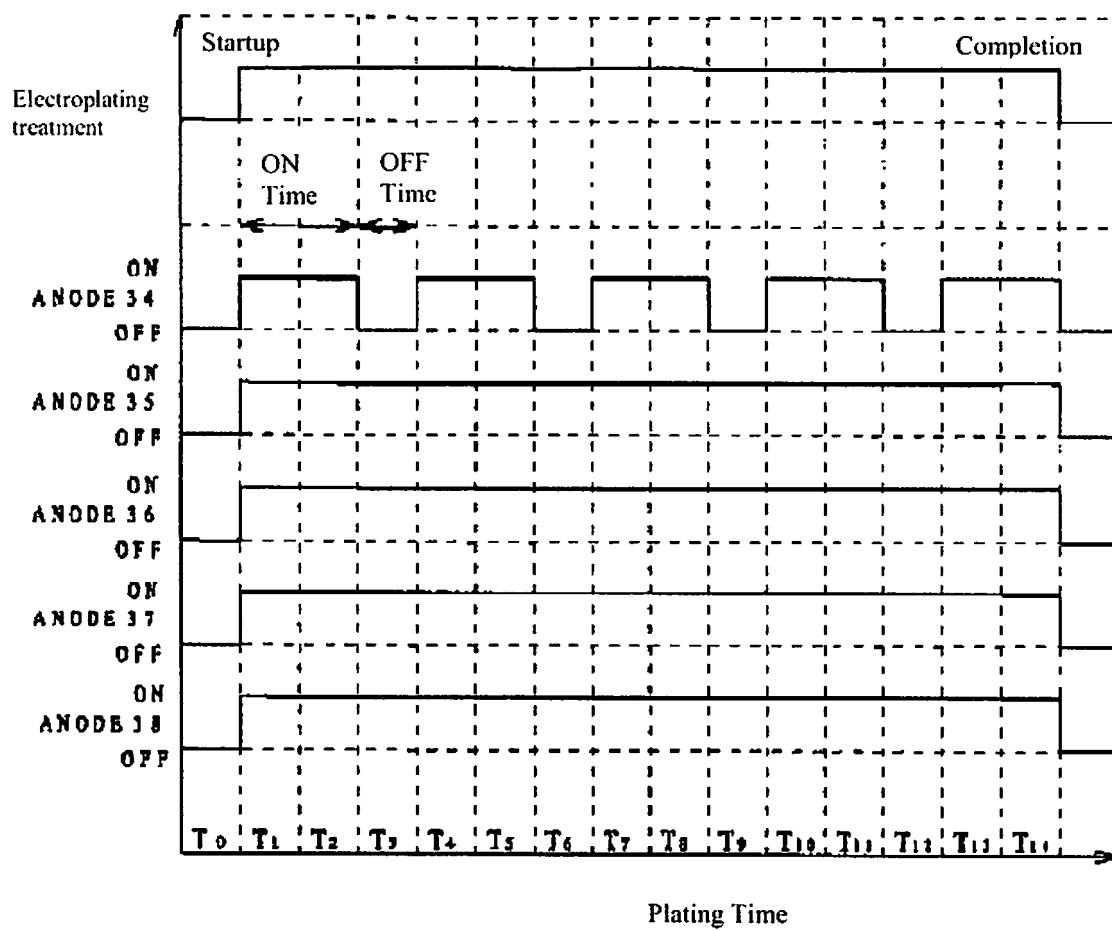


Fig. 5

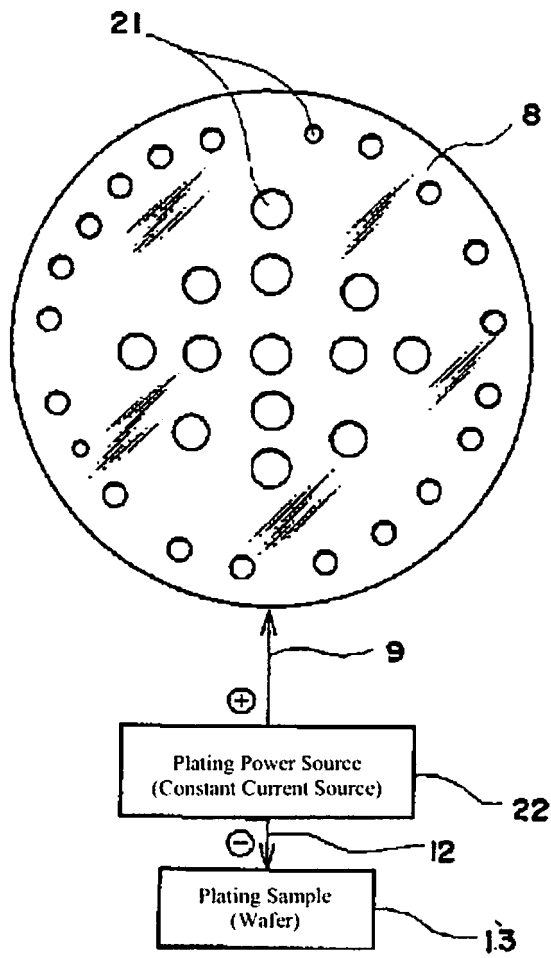


Fig. 6

